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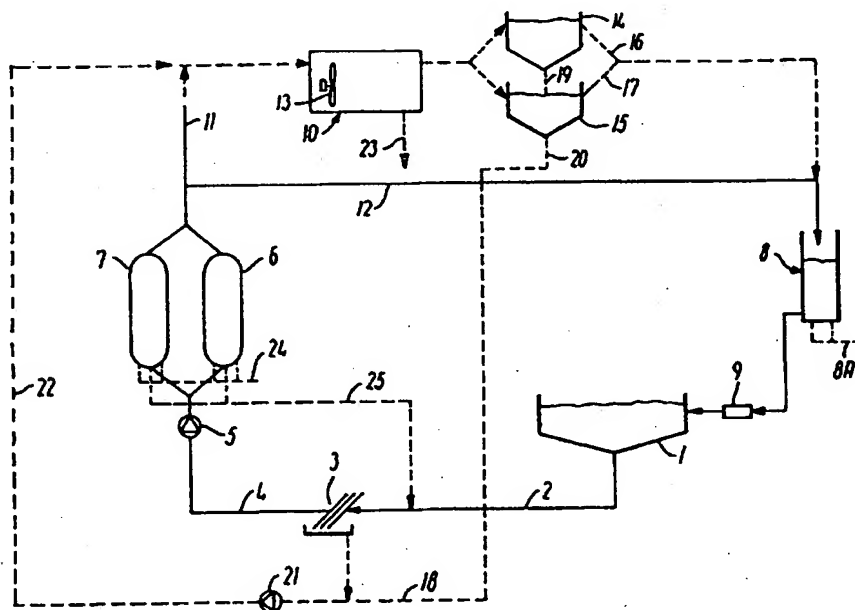
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**(54) Title: A SYSTEM AND A METHOD FOR AQUATIC PRODUCTION**



**(57) Abstract**

The system comprises a growing tank (1) and recycling circuits for the water of the tank with a mechanical filter (3) for removal of particles from the water, a biofilter (6, 7) for nitrification of ammonia to nitrate, a device for oxygen supply (8), and a device (10, 14, 15) for denitrification of nitrate to free nitrogen comprising a tank (10) with suspended active sludge followed by a device (14, 15) for mechanical separation of sludge and water.

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## A SYSTEM AND A METHOD FOR AQUATIC PRODUCTION

The present invention relates to a system for aquatic production comprising a growing tank and recycling circuits for the water of the tank with a mechanical filter for removal of particles from the water, a biofilter for nitrification of ammonia into nitrate, and a device for denitrification of nitrate to free nitrogen, as well as a device for oxygen supply. A system of this type is known from JP-A-5 277 495, which discloses a system, in which the device for denitrification comprises a bed of filter sand with denitrifying bacteria at the bottom of a water tank, the water of which is circulated.

The invention further relates to a method for running a system for aquatic production with recycling, in which system water from a growing tank is circulated through a mechanical filter for removal of particles, a biofilter for nitrification of ammonia to nitrate, and oxygen is supplied to the water.

In systems for aquatic production, such as fish growth, the water in the growing tank or tanks is polluted by surplus fish feed, excrements and ammonia, which the fish excrete as a metabolic waste product. The ammonia is toxic for the fish and therefore has to be removed from the water, which in a common growing system with recirculation takes place by means of a biofilter, in which bacteria convert ammonia to nitrate in an aerobic process.

It is, however, necessary to remove the nitrate created in the biofilter from the water in order not to get an accumulation thereof in the water, and in conventional systems this nitrate is currently removed by changing part of the water.

As the process in a biological filter is oxygen consuming, the water is normally subjected to aeration before it is taken back to the growing tank, just as the water usually is disinfected by means of UV- rays and/or addition of ozone to part of the recycled water.

The exchange of water in order to get rid of the nitrate and other waste products is a substantial problem when running a growing system, partly because the accumulated waste products constitute a threat to the environment, partly because a huge amount of water is required.

The object of the invention is to provide a system and a method for aquatic production, according to which it substantially is not necessary to exchange the growing water, and where the environmental impact is minimal.

This object is met by means of a system of the type mentioned by way of introduction, said method being characteristic in that the device for denitrification comprises a tank with suspended active sludge followed by mechanical equipment for separating water and sludge.

The object is further met by means of a method of the type mentioned above, which is characteristic in that the water is further circulated through a tank with suspended active sludge for denitrification of nitrate to free nitrogen and subsequently through a device for mechanical separation of sludge and water.

In a preferred embodiment of the method according to the invention the material filtered off in the mechanical filter is led to the tank with suspended active sludge. Hereby is obtained that the filtered off material which in conventional growing systems has to be disposed of and consequently affects the environment, serves as nutrient for the denitrification process, for which reason the need for disposal of separated material is considerably reduced.

In a further embodiment the water is led to the tank with suspended active sludge from the biological filter, whereby is obtained that the water which is led to the tank with suspended active sludge is substantially free from oxygen.

The invention may be used in connection with water with a salt concentration corresponding to that of fresh water, brackish water or sea water, i.e. 0-3.6% and even up

to 5.5%.

It has surprisingly turned out to be possible to use suspended active sludge for the denitrification and subsequently to precipitate the sludge to such an extent that fish may subsequently thrive in the water. By using suspended active sludge for the denitrification it becomes possible to carry on this process continuously, as there is no solid filter mass to be cleaned or regenerated from time to time.

The invention will be described in detail in the following by means of embodiments with reference to the drawing, in which

Fig. 1 schematically shows a system for fish growth with a recirculation circuit, and

Fig. 2 a second system with a second recirculation circuit.

Fig. 1 thus shows a growing system comprising a conventional system, the components of which are connected with pipes, which are shown with fully drawn lines, and an extension according to the invention, which is connected with the conventional part by means of pipes shown as broken lines.

The conventional part comprises one (or more) growing tanks 1, a mechanical filter 3, a biofilter, here in the shape of two parallelly disposed filters 6, 7, an oxygen supply device 8 with air supply 8A and a possible disinfection device 9. The growing tank 1, the mechanical filter 3, the biofilters 6, 7 and the oxygen supply device 8 are connected by means of pipes 2, 4, and 12, the pipe 4 comprising a pump sump for a circulation pump 5.

As something new the system comprises an anoxic tank 10, to which a variable partial current may be led from the biological filters 6, 7 through a pipe 11 instead of being led directly through the pipe 12 to the oxygen supply device 8. The anoxic tank 10 contains suspended active sludge which is kept in suspension by means of a stirrer 13. From the anoxic tank 10 pipes lead to two parallelly

driven settling tanks 14, 15, from which overflows 16, 17 lead back to the main stream from the biofilters 6, 7 and to the oxygen supply device 8.

Moreover, a common container 18, which in the drawing is just shown as a pipe, is provided. Sedimentary sludge is led to this common container 18 from the sedimentation tanks 14, 15 through pipes 19, 20, and to the common container 18 also rinsing water from rinsing of the mechanical filter 3 is led. Water, sludge and material filtered off by the mechanical filter 3 are by means of a pump 21 pumped to the anoxic tank 10 through a pipe 22.

During operation water is recycled from the growing tank 1 through the pipe 2 to the mechanical filter 3 and further on to the pump sump 4. The mechanical filter is to be rinsed now and again, and the cleansing water is taken from the pump sump 4 and led together with the material filtered off to the drainage tank 18.

By means of the circulation pump 5 the filtered water is pumped through the biofilters 6, 7 and therefrom the main flow is led through the pipe 12 to the oxygen supply device 8. A variable partial current is led to the anoxic tank 10 which contains suspended active sludge, in which a denitrification takes place, nitrate ( $\text{NO}_3$ ) being transformed into free nitrogen ( $\text{N}_2$ ). A prerequisite for the success of this process is that free oxygen is substantially not present in the anoxic tank. In some cases it has turned out that the amount of organic material, which is supplied from the filter 3 in form of filtered off feed remnants and excrements, etc. is not sufficient for ensuring complete exhaust of the oxygen present. Therefore, additional organic material, for instance sugar, is added, partly to reduce the oxygen contents, partly to establish the carbon source necessary for nourishing the denitrification process.

Water with part of the sludge is led from the anoxic tank to the settling tanks 14, 15, in which the sludge is deposited and brought through the pipes 19, 20 to the

common tank 18, from where it is pumped back to the anoxic tank 10. The defecated water is led through the overflow pipes 16, 17 back to the main flow and to the aeration container 8. During the process in the anoxic tank 10 a  
5 sludge is created, for which reason excess sludge is removed through the bottom of the tank 10 as shown by the arrow 23 and removed from the system.

The suspended sludge in the anoxic tank 10 has in the example described been produced by means of microorganisms  
10 from the environment, which during the operation of the system has formed a colony in the tank 10, as the right conditions prevailed, i.e. nitrate and organic carbon were present, but on the whole no free oxygen.

The biofilters 6, 7 do in the example contain a  
15 matrix of a plastics material, on the surface of which nitrifying bacteria deposit during the operation of the system. These are for instance Nitrosomonas and Nitrobakter. A nitrification takes place in the biological filters 6, 7, ammonia being converted into nitrate. This  
20 process is pH-dependent and a pH above 8 is therefore aimed at.

This is in conventional systems made by means of a necessary addition of calcium carbonate ( $\text{CaCO}_3$ ). This addition of calcium carbonate has surprisingly turned out  
25 to be superfluous in the system described, because the denitrifying process apparently establishes an alkalinity which corresponds to the one consumed by the nitrifying process.

The biofilters 6, 7 are cleaned like in conventional  
30 systems from time to time (for instance by blowing in air 24), and the separated sludge is led through a pipe 25 to the mechanical filter 3 to end up in the anoxic tank 10, where it takes part in the current process.

Apart from the operation described above with fresh  
35 water, the inventors have performed sea water operation. In the sea water operation for instance a salt concentration of 3.6% is used and a starting culture is introduced in the

system, said culture comprising a mixture of salt-tolerant, nitrifying and denitrifying bacteria. The system has turned out surprisingly to function satisfactorily with sea water operation without a feared development of  $H_2S$ , which is very toxic to fish.

Fig. 2 shows in a schematic diagram a modification of the system according to Fig. 1. In the system shown in Fig. 2 all the water, which through the anoxic tank 10 is recycled from the growing tank 1, is cleansing water from cleaning of the mechanical filter 3. Furthermore, a pipe 26 with a pump 27 has been introduced between the pump sump 4 and the pipe 12 in such a way that it is possible to lead only part of the water filtered off in the mechanical filter 3 through the biofilters 6, 7.

Two different circuit configurations have been shown and described, but it is to be understood that several others are possible.



## C L A I M S

1. A system for aquatic production comprising a growing tank (1) and recycling circuits for the water of the tank with a mechanical filter (3) for removal of particles from the water, a biofilter (6, 7) for nitrification of ammonia into nitrate, and a device (10, 14, 15) for denitrification of nitrate to free nitrogen, as well as a device for oxygen supply,

characterized in that the device for denitrification comprises a tank (10) with suspended active sludge followed by a device (14, 15) for mechanical separation of sludge and water.

2. A system according to claim 1,

characterized in that the device (10, 14, 15) for denitrification is connected with the biological filter (6, 7) in series after the biological filter.

3. A method of running a system for aquatic production with recycling, in which system water from a growing tank (1) is circulated through a mechanical filter (3) for removal of particles, a biological filter (6, 7) for nitrification of ammonia to nitrate, and oxygen is supplied to the water,

characterized in that the water is further circulated through a tank (10) with suspended active sludge for denitrification of nitrate to free nitrogen and subsequently through a device for mechanical separation of sludge and water.

4. A method according to claim 3,

characterized in that the material filtered off in the mechanical filter is led to the tank (10) with suspended active sludge.

5. A method according to claims 3 and 4,

characterized in that the sludge separated in the device (14, 15) for separating sludge and water is returned to the tank (10) with suspended active sludge.

6. A method according to claims 3-5,

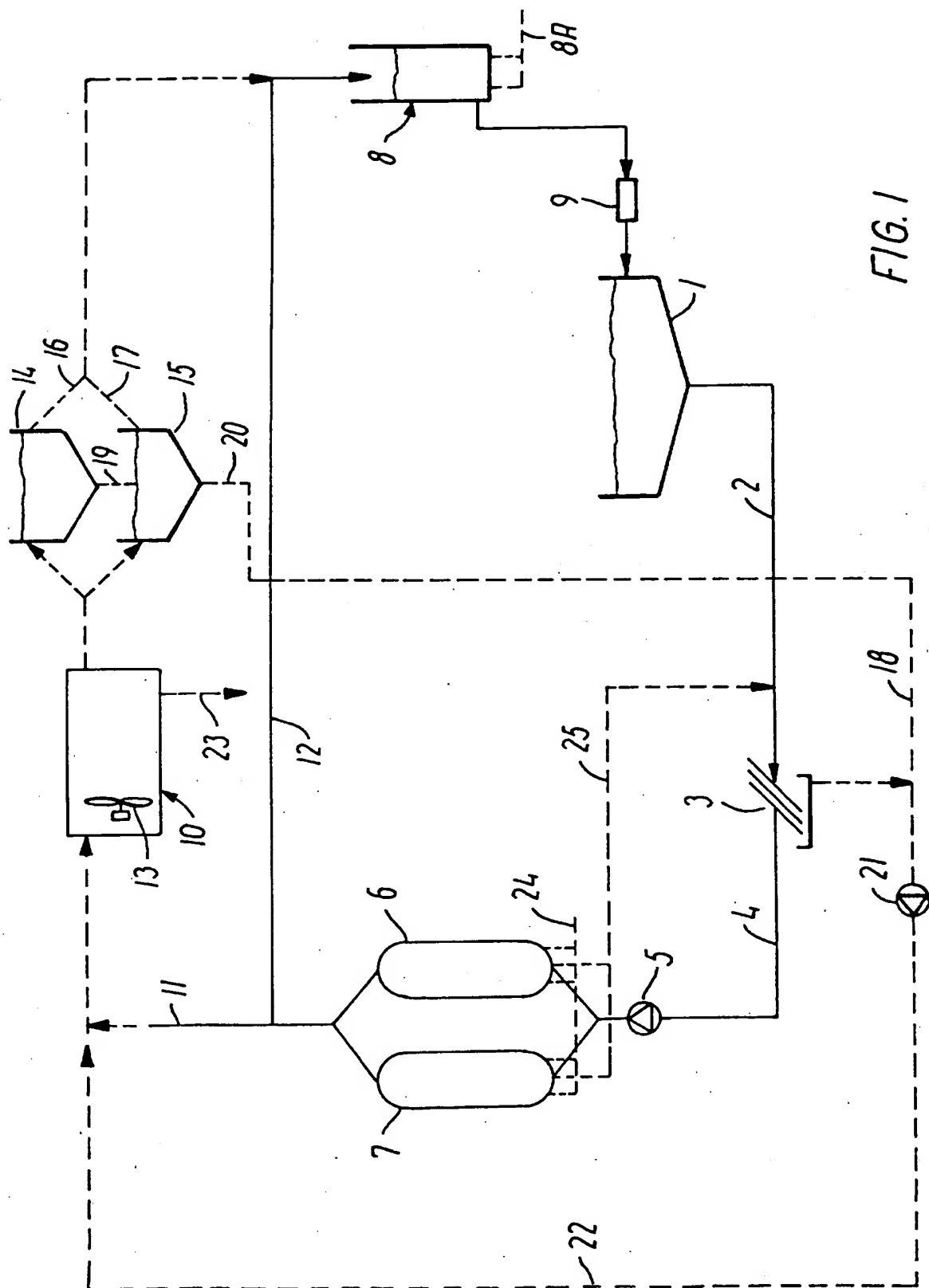
c h a r a c t e r i z e d in that the water is led to the tank (10) with suspended active sludge from the biological filter (6, 7).

7. A method according to claims 3-6,

5 c h a r a c t e r i z e d in that carbonaceous, organic material, for instance sugar, is added to the tank (10) with suspended active sludge.

8. A method according to claims 3-7,

10 c h a r a c t e r i z e d in that the water has a salt concentration (Nail) of 0-5.5%, preferably 0-3.6%.



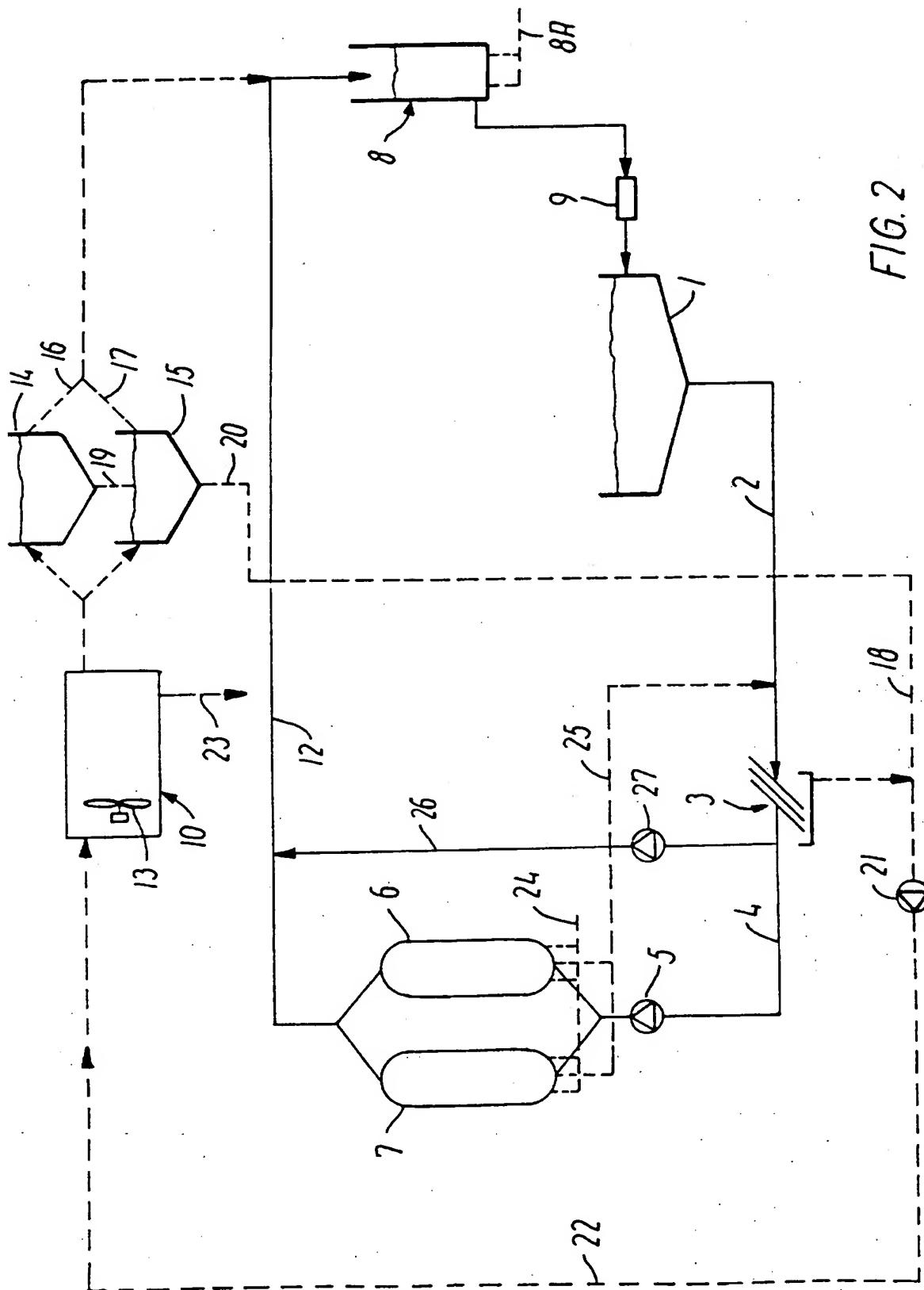


FIG. 2

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 95/00325

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A01K 63/04, C02F 3/30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A01K, C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

30/10/95

International application No.

PCT/DK 95/00325

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